

**Claims:**

What is claimed is:

- 1           1.       A method of coating a surface of a substrate with a polymer  
2 solution, comprising:  
3                       mounting the substrate inside an enclosed housing;  
4                       controlling a solvent vapor concentration of a control  
5 gas to be greater than approximately 50% (saturation);  
6                       passing the control gas into the housing through an  
7 inlet;  
8                       extruding the polymer solution onto the surface of the  
9 substrate in the housing;  
10                      spinning the substrate; and  
11                      exhausting the control gas and any solvent vapor and  
12 particulate contaminants suspended in the control gas from the housing  
13 through an outlet.
- 1           2.       The method of claim 1, wherein the substrate is a wafer having  
2 a top surface, a center, and an outer edge; and  
3                      wherein extruding the polymer solution comprises extruding a ribbon  
4 of photoresist, the ribbon having a width, the ribbon covering the entire top  
5 surface of the substrate in a spiral pattern, wherein the photoresist is extruded  
6 from the extrusion slot at a rate which is a constant extrusion rate, and with the  
7 substrate rotating at a rotational speed, and the extrusion head moving at a  
8 radial speed, the motion of a radially moving extrusion head with respect to  
9 the rotating substrate is at a tangential velocity which is a constant tangential  
10 velocity.

1           3.       A method according to claim 2, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the outer edge of the  
3 wafer and ending at the center of the wafer.

1           4.       A method according to claim 2, wherein the ribbon of  
2 photoresist is extruded in a spiral pattern beginning at the center of the wafer  
3 and ending at the outer edge of the wafer.

1           5.       A method according to claim 2, wherein the width of the  
2 photoresist ribbon is between about one tenth and about one third of the  
3 diameter of the wafer.

1           6.       The method of claim 1, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3 an outer edge;  
4           mounting the substrate inside an enclosed housing includes mounting  
5 the wafer on a chuck, the top surface of the wafer aligned horizontally and  
6 oriented upward; and  
7           extruding the polymer solution comprises:  
8           positioning an extrusion head adjacent to the outer edge of the wafer  
9 and above the top surface of the wafer, the extrusion head configured to  
10 extrude photoresist out an extrusion slot, the extrusion slot having a length

11 bounded by a first end and a second end, the extrusion head positioned with  
12 the extrusion slot aligned radially with respect to the wafer, the first end of the  
13 extrusion slot located adjacent to the outer edge of the wafer, and the second  
14 end of the extrusion slot outside the outer edge of the wafer,

15 rotating the wafer about its center, wherein with the wafer rotating at a  
16 rotational speed, and the extrusion head moving at a radial speed, the motion  
17 of a radially moving extrusion head with respect to the rotating wafer is at a  
18 tangential velocity which is a constant tangential velocity;

19 extruding a ribbon of photoresist from the extrusion slot, the ribbon  
20 having a width which is substantially equal to the length of the slot, wherein  
21 the photoresist is extruded from the extrusion slot at a rate which is a constant  
22 extrusion rate, and

23 while extruding photoresist from the extrusion slot, and maintaining  
24 the extrusion slot aligned radially with respect to the wafer, moving the  
25 extrusion head radially inward from the outer edge of the wafer toward the  
26 center of the wafer until the photoresist covers the entire top of the surface of  
27 the wafer.

1 7. A method according to claim 6, wherein the length of the  
2 extrusion slot is between about one tenth and one third of the diameter of the  
3 semiconductor wafer.

1           8.       A method according to claim 6, wherein maintaining the  
2   extrusion slot aligned radially with respect to the wafer further comprises  
3   uniformly maintaining the extrusion slot at a distance above the top surface of  
4   the wafer.

1           9.       A method according to claim 6, wherein maintaining the  
2   extrusion slot aligned radially with respect to the wafer further comprises  
3   determining a distance between the extrusion slot and the top surface of the  
4   wafer, and adjusting the position of the extrusion slot to maintain the distance.

1           10.     A method according to claim 9, wherein maintaining the  
2     extrusion slot aligned radially with respect to the wafer further comprises  
3     determining a distance between the extrusion slot and the top surface of the  
4     wafer using an optical sensor.

1            11.        A method according to claim 6, wherein the photoresist ribbon  
2        is coated onto the wafer in a spiral pattern which covers the entire top surface  
3        of the wafer.

1            12.     A method according to claim 11, comprising the steps of  
2            removing the extrusion head, and  
3            rotating the wafer at high speed.

1           13.     The method of claim 1, wherein:  
2           the substrate is a wafer having a top surface, a center, a diameter, and  
3     an outer edge;  
4           mounting the substrate inside an enclosed housing comprises mounting  
5     the wafer on a chuck; and  
6           extruding the polymer solution comprises:  
7           positioning an extrusion head at the center of the wafer and above the  
8     top surface of the wafer, the extrusion head configured to extrude photoresist  
9     out an extrusion slot, the extrusion slot having a length bounded by a first end  
10    and a second end, the extrusion head positioned with the extrusion slot aligned  
11    radially with respect to the wafer, the first end of the extrusion slot located at  
12    the center of the wafer and the second end of the extrusion slot located  
13    between the center of the wafer and the outer edge of the wafer,  
14           rotating the wafer about its center wherein with the wafer rotating at a  
15    rotational speed, and the extrusion head moving at a radial speed, the motion  
16    of a radially moving extrusion head with respect to the rotating wafer is at a  
17    tangential velocity which is a constant tangential velocity,  
18           extruding a ribbon of photoresist from the extrusion slot, the ribbon  
19    having a width substantially equal to the length of the slot, wherein the  
20    photoresist is extruded from the extrusion slot at a rate which is a constant  
21    extrusion rate, and  
22           while extruding photoresist from the extrusion slot, and maintaining  
23    the extrusion slot aligned radially with respect to the wafer, moving the

24 extrusion head radially outward toward the outer edge of the wafer until the  
25 photoresist covers the entire top surface of the wafer.

1 14. The method of claim 1, wherein controlling a solvent vapor  
2 concentration comprises  
3 passing a first solvent vapor-bearing gas and a second gas to the  
4 housing along conduits in which electrically-controlled valves are mounted,  
5 the valves controlling a gas flow rate into the housing and the composition of  
6 the control gas flowing into the housing.

1 15. The method of claim 2, wherein controlling a solvent vapor  
2 concentration comprises  
3 passing a first solvent vapor-bearing gas and a second gas to the  
4 housing along conduits in which electrically-controlled valves are mounted,  
5 the valves controlling a gas flow rate into the housing and the composition of  
6 the control gas flowing into the housing.

1 16. The method of claim 6, wherein controlling a solvent vapor  
2 concentration comprises:  
3 passing a first solvent vapor-bearing gas and a second gas to the  
4 housing along conduits in which electrically-controlled valves are mounted,  
5 the valves controlling a gas flow rate into the housing and the composition of  
6 the control gas flowing into the housing.

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1           19.       The method of claim 2, wherein the control gas comprises at  
2   least one species selected from a group consisting of air, nitrogen, and noble  
3   gases.

1           20.       The method of claim 6, wherein the control gas comprises at  
2   least one species selected from a group consisting of air, nitrogen, and noble  
3   gases.

1            21.        The method of claim 13, wherein the control gas comprises at  
2        least one species selected from a group consisting of air, nitrogen, and noble  
3        gases.

1           22.    The method of claim 1, wherein the polymer solution contains  
2   a photoresist polymer.

1           23.    The method of claim 2, wherein the polymer solution contains  
2   a photoresist polymer.

1           24.    The method of claim 6, wherein the polymer solution contains  
2   a photoresist polymer.

1           25.    The method of claim 13, wherein the polymer solution contains  
2   a photoresist polymer.

1           26.    The method of claim 1, further comprising passing solvent-free,  
2   humid gas over the coated substrate.

1           27.    The method of claim 2, further comprising passing solvent-free,  
2   humid gas over the coated substrate.

1           28.    The method of claim 6, further comprising passing solvent-free,  
2   humid gas over the coated substrate.



1           29.    The method of claim 13, further comprising passing solvent-  
2 free, humid gas over the coated substrate.

1           30.    The method of claim 26, wherein a humidity of the humid gas  
2 is controlled by means of a temperature and humidity controller.

1           31.    The method of claim 30, wherein the humidity of a humid gas  
2 is controlled to have the relative humidity in the range of 40% to 45%.

1           32.    The method of claim 1, wherein the temperature of the humid  
2 gas is controlled by means of a temperature and humidity controller.

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